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Destabilization of light element hydrides with high hydrogen capacities: metal imides/nitrides

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High hydrogen capacity materials are highly desirable for hydrogen storage for on-board applications. Some light elements form hydrides with high hydrogen capacities, such as LiH (12.7 wt%) and MgH_2 (7.6 wt%). These hydrides, however, are very stable, releasing hydrogen only at very high temperature, above 600^oC and 350^oC, respectively, with poor kinetics. These hydrogen storage features are unsatisfactory for on-board application. Chen et al [1] reported the hydrogen storage properties of lithium nitride/imide. According to their results lithium imide can absorb hydrogen at 1 bar at 285^oC reversibly with hydrogen capacity of 6.5wt%. Lithium nitride, on the other hand, can absorb 5wt% more hydrogen, however, it is much more stable compared with lithium imide.

$$Li_3N + 2H_2 \ (Li_2NH + LiH + H_2 \ (\ LiNH_2 + LiH$$

This indicates that it is an effective method to destabilize lithium hydride by converting hydride to nitrogen-containing material, such as lithium imide/nitride. Here we report a new approach to further de-stabilize lithium imide by partial substitution of lithium by magnesium in this system. This Mg-substituted material releases hydrogen of significant higher pressure at much lower temperature than those for lithium imide, with minimal capacity reduction [2]. One of the examples is the mixture of ($LiNH_2$-MgH_2), which can release hydrogen of approximately 30 bar at 200^oC reversibly, with hydrogen capacity of 5 wt%. This material has the potential to deliver hydrogen of 3 bar at 100^oC. It may be further dehydrogenated to nitride with total hydrogen capacity of approximately 9wt%. The destabilization mechanism for this system will be discussed since this may provide clue in the future searching for high capacity hydrogen storage materials [1] P. Chen, Z. Xiong, J. Luo, J. Lin, L Tan, Nature Vol. 420 (2002) 302-304. [2] W. Luo, J. Alloys and Compounds, 381 (2004) 284-287.